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THE SUCCESSFUL APPLICATION

OF

CHARCOAL AIR-FILTERS

TO

THE VENTILATION
AND DISINFECTION OF SEWERS.

A Letter

TO THE RIGHT HONOURABLE THE LORD MAYOR,

WILLIAM CUBITT, M.P.



BY

JOHN STENHOUSE, LL.D., F.R.S.,

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L
L O N D O N :

JOHN CHURCHILL, 11, NEW BURLINGTON STREET,

MDCCCLXI.

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ON THE SUCCESSFUL APPLICATION
OF
CHARCOAL AIR-FILTERS
TO THE
VENTILATION AND DISINFECTION OF SEWERS.

MY LORD MAYOR,

The high position you have attained by your professional ability as a Builder, together with the circumstance that you are the chief magistrate of the largest city in Europe, have induced me to address to you a few observations on the very important subject of the ventilation and disinfection of the sewers. When we consider that the sewers of London, pervading as they do every part of the metropolis, extend to some 1,500 miles, and that almost every house is more or less intimately connected with them, it is plain that their influence, in a sanitary point of view, cannot readily be over-estimated.

A badly-constructed or ill-regulated sewer is truly the modern Pandora's box, which contains within it many of the most dangerous diseases, such as

typhus fever, cholera, dysentery, scarlatina, diphtheria, &c., ever ready to break forth and assail the hapless inhabitants of the neighbourhood. Now this is no poetical figure merely, but, unfortunately, it is but too often the sad experience of the inhabitants of every large town where sanitary regulations have been neglected. The ventilation of the sewers is not a matter of choice, for if they are not furnished with artificial openings they will ventilate themselves, for the large quantities of deleterious gases, produced by the putrefactive fermentation of the organic matters in the sewers, will overcome very considerable resistance, and force their way into the adjoining streets and houses, oftentimes with the most fatal effects. These lamentable results are by no means confined to the poorest localities, but not unfrequently occur even in the finest districts of our largest towns. In this way, through the ignorance and carelessness of some architects, who have neglected the most ordinary sanitary precautions in regard to the drainage, the most splendid houses are not unfrequently the most unhealthy. Till within the last few years, the ventilators for the sewers were reduced to as small a number as possible, and always placed in the centres of the streets, on account of the disagreeable and dangerous effluvia which, especially in warm weather, these air-holes were too apt to emit. At present, however, these air-holes may be increased to any extent, and placed in any situation; for since the application of the charcoal air-filters to the ventilating shafts of the sewers, the effluvia and

deleterious gases are effectually arrested and destroyed, by being subjected to a species of low combustion, which resolves their carbon into carbonic acid, their hydrogen into water, and their nitrogen into ammonia.

The nature and origin of the charcoal air-filter is simply as follows. It has long been known that the various kinds of animal and vegetable charcoal, especially when dry, possess the power of absorbing effluvia, and the greater number of gases and vapours. The subject was first investigated by M. Löwitz, a German chemist, who, toward the close of the last century, showed that charcoal might be made to deodorize and disinfect most putrid substances. About seven years ago, it was discovered by Mr. John Turnbull, of Glasgow, that when the bodies of dead animals are covered over with a few inches of powdered charcoal, and exposed to the air, though the bodies rapidly decay, not the slightest disagreeable odour is evolved. This result I verified in 1853, by burying the bodies of a full-grown cat and two rats, in about two inches of charcoal powder, and keeping them in my laboratory. The bodies of the animals rapidly decayed, but not the slightest odour was perceptible, nor were any injurious consequences experienced by any of the eight or nine persons by whom the laboratory was daily frequented. Toward the close of 1853, my attention was first directed to the deodorizing and disinfecting properties of charcoal, and I was not long in discovering that the views which had been previously entertained regard-

ing the action of charcoal were exceedingly erroneous; for instead of acting as an antiseptic, and thereby retarding the decay of putrefying substances with which it was in contact, as had been previously supposed, its action was the very reverse of this. Charcoal, therefore, from the considerable amount of condensed oxygen contained within its pores, amounting to between nine and ten volumes, not only absorbs, but rapidly oxidizes the effluvia and miasmata emitted by decaying substances, and resolves them into the simplest combinations they are capable of forming.

All porous substances, such as platinum black, pumice stone, &c., possess the power of condensing gases within their pores.

The porosity of charcoal is much greater than many persons are aware of. Liebig states, in his "Letters on Chemistry," that the pores in a cubic inch of beech-wood charcoal must, at the lowest computation, be equal to a surface of 100 square feet.

When reflecting on the wonderful power of charcoal as a deodorizer and disinfectant, as exhibited in the cases already described, where, as we have seen, a layer of charcoal not more than two inches in thickness is capable of absorbing all the miasmata from such an extensive source of corruption as the putrid body of a large animal, it struck me that a thin layer of charcoal powder interposed between wire gauze would be equally effective in preventing the noxious effects which too frequently result from the very minute quantity of putrid infectious matter

floating in the air of what are generally known as unhealthy situations.

These considerations led me to construct the so-called charcoal air-filter for the purification of the atmosphere, which was first publicly exhibited and described by me at the meeting of the Society of Arts, on the 22nd of February, 1854.

The charcoal air-filter consists of a layer of charcoal in coarse powder, varying in size according to circumstances, between a small bean and a filbert. The charcoal is placed between two sheets of wire gauze fixed in a frame, and can be readily applied to buildings, to ships, to the air-shafts of sewers, to water-closets, to respirators, and various other purposes. All the impurities in the air are absorbed by the charcoal, so that a current of pure air alone passes through the filter, and in this way pure air may be obtained from exceedingly impure sources. It is plain that perforated zinc, or a framework of coarse wire filled with larger pieces, and a greater thickness of charcoal, may be also employed, whenever the amount of effluvia evolved is very considerable.

Before the close of the year 1854, air-filters or charcoal ventilators were fitted up both at the Mansion House and Guildhall. They are each of them several feet in diameter, the layer of charcoal being about one-and-a-half inches in thickness. Although six years have elapsed, the charcoal has never required to be renewed, owing to its oxidating power being practically unlimited. Air-filters were soon

afterwards largely employed in private houses, in connexion with drains and water-closets particularly, and they were also very successfully applied to the construction of respirators, many thousands of which have ever since been annually manufactured by Mr. W. B. Rooff, of 7, Willow Walk, Kentish Town. On the 2nd of March, 1855, I delivered a lecture at the Royal Institution, on the Economical Application of Charcoal to Sanitary Purposes. It was subsequently published by Churchill, and passed through three editions. In it, the preceding and many additional facts were made known to the public.

Some time after the publication of this lecture, Mr. Robert Rawlinson, the eminent engineer, was induced to apply the charcoal filter in the beginning of the year 1856 to the air-shafts of sewers. The charcoal filters are so arranged, that while the charcoal is kept dry the whole of the air issuing from the sewer is made to pass through the charcoal, by which all its impurities are retained and destroyed, nothing but pure air passing up into the street. From the extreme porosity of the charcoal it does not sensibly injure the draught of the air-shafts, and by increasing the size of the filter—for instance, by doubling its diameter, or what is perhaps much better, by adding to their number—any diminution of air-way may be easily prevented. These filters, from their simplicity, are by no means costly in their construction, and if kept dry, the charcoal never requires to be renewed.

Mr. Rawlinson has hitherto employed tolerably

thick single filters placed perpendicularly. I should prefer using two or more thin filters placed at short distances, say two inches, from each other. These thin filters disinfect the air quite as efficiently as a single thick one, and I think they present rather less obstruction to the air. There is this disadvantage also attending the use of the upright filters, that after a time the charcoal is apt to subside a little, and leave an opening at the top, through which a portion of the air may escape. This, however, is easily prevented by placing a bar of wood or metal, from two to three inches broad, right across the upper part of the outside of the filter. When this has been done, even should the charcoal subside for an inch or so at the top of the filter, no air will be able to pass through which has not been disinfected by the charcoal.

I purposely omit any engineering details of their construction, as I understand Mr. Rawlinson intends publishing a paper on the subject, in which these will be fully described. As will be seen by the subjoined letter, Mr. Rawlinson, during the last four years, has applied charcoal air-filters to the ventilation of sewers on a large scale, at West Ham, near London, at Swansea, Worksop, and Buxton, the entire towns; at Brighton partially; at Bowood, the seat of Lord Lansdowne, and at various other places.

In 1858 a very important and able report on the state of the sewers, and the various means which have been proposed for disinfecting them, was pub-

lished by Dr. Letheby, Health Officer of the City of London, and Lecturer on Chemistry and Medical Jurisprudence in the Medical College of the London Hospital. After a minute and rigorous examination of the various methods proposed for disinfecting the sewers of London, some of which were enormously expensive, those with bleaching powder and permanganate of soda being estimated to cost from 200,000 to 270,000 pounds for a single year, Dr. Letheby strongly recommended the employment of charcoal air-filters, as infinitely the cheapest and most effective of all the plans which had been proposed. About a year ago, therefore, under Dr. Letheby's directions, Mr. Haywood, the well-known Engineer to the City Commissioners of Sewers, commenced applying the charcoal filters to the ventilation of the sewers in Shoreditch, and in many of the adjoining streets, which were well known to suffer more from the sewerage exhalations than almost any of the other districts in London. Mr. Haywood employed tolerably thin horizontal charcoal filters, three or four being placed one above the other on a stalk, with short distances between them, the pieces of charcoal being from one inch to an inch and-a-half in length, and placed in single layers, while Mr. Rawlinson, as already mentioned, employed single perpendicular filters. In both cases the results have been perfectly satisfactory, as the sewer gases are as effectually destroyed by being subjected to a species of low combustion, as if they had been passed through a red-hot furnace. In this

process the charcoal is not acted on by the gases, but acts upon them, as before stated, causing them to combine with condensed oxygen. The efficiency of the charcoal appears never to diminish, if it is kept dry and its pores are not choked up by dust.

The expense of applying charcoal to the disinfection of the sewers is by no means considerable, as the first outlay is all that is required. I am informed that the changes rendered necessary by the introduction of charcoal ventilators for the sewers in the extensive district of Shoreditch, have been under £1,000. But had these sewers been originally constructed with a view to the employment of the charcoal ventilators, the expense would have been considerably less.*

One great advantage of the charcoal system is, that it enables us to make as many openings into the sewers as we please, and thus prevents any considerable quantity of the gases accumulating at any one point, as they pass up into the filters and are destroyed almost as rapidly as they are formed. Such sewers have, therefore, all the advantages of open drains, without any of their disadvantages. Hence there can never be any considerable pressure on the traps of the house-drains, one of the great disadvantages attendant on the ordinary system of sewers. It is by no means indispensably necessary that the charcoal filters should be placed only in the

* For all engineering details, I beg to refer the reader to Mr. Haywood, who, I believe, intends reporting on the subject.

ventilating shafts of the sewers. The air-holes in the centres of the streets may be closed, if thought desirable, and the gases conducted by means of wide pipes into charcoal filters, placed at the edges of the pavement, or inserted into the walls of the houses. The lower portions of the lamp-posts enlarged for this purpose, or short pillars like letter-boxes, either standing at the edges of the pavement, or inserted into the walls of the houses, will answer perfectly well. The only precautions to be observed are, that while the filters shall be sheltered from rain and moisture, free access shall be given to the air.

In conclusion I may state, that for the last six years I have strongly recommended that charcoal air-filters should be applied to all house-drains, sinks, and water-closets.

SPECIAL APPLICATION OF THE FILTERS TO WATER-CLOSETS.

Every water-closet, in my opinion, ought to be furnished with a subsidiary pipe branching off from the main pipe, a little below the valve of the closet. This subsidiary pipe should be carried a few feet above the seat of the closet; and its extremity, which should be open, with the exception of a few wires stretched across it, merely to prevent the charcoal falling into it, should terminate in a charcoal filter six or eight inches thick, into which it

should penetrate to the depth of two or three inches, so as, in fact, to be enclosed by a good body of charcoal. Under such an arrangement as this, no foul gases can penetrate into the closet, but will be retained and destroyed by the charcoal, into which they naturally flow, as in this direction scarcely any resistance is offered to their passage; whereas, in almost all water-closets as hitherto constructed, every time that the handle is drawn up, the water which descends necessarily forces a quantity of foul air into the closet, and this foul air not unfrequently passes from the closet into the other apartments of the house.

From the preceding statements it is plain, that the oxygen contained in the air of the atmosphere is by far the cheapest and most effective deodorizing and disinfecting agent with which we are acquainted, and that the usefulness of the charcoal air-filter consists in its affording a safe and advantageous means of applying atmospherical air to disinfecting purposes.

I think it but justice to myself to state that I have no pecuniary interest in the charcoal air-filter. Though strongly urged to do so, I refrained from securing it by patent, on the ground that inventions for the prevention of disease and death ought to be sold at the lowest possible price; and should not, therefore, be encumbered with the expense and restrictions attendant upon patent rights.

I trust the importance of this subject will be my excuse for intruding on your Lordship's notice; and

respectfully requesting your Lordship's attention to
the accompanying certificates,

I remain,

Your Lordship's obedient Servant,

(Signed) JOHN STENHOUSE, LL.D., F.R.S.,

Late Lecturer on Chemistry at
St. Bartholomew's Hospital.

17, RODNEY-ST., PENTONVILLE, N.

Dec. 11, 1860.

APPENDIX.

Letter from Dr. LETHEBY, Health Officer to the City of London,
Lecturer on Chemistry and Medical Jurisprudence in
the College of the London Hospital, &c.

GUILDHALL, LONDON,
Dec. 11, 1860.

DEAR DR. STENHOUSE,—

In reply to your question, as to the efficacy of the Charcoal Ventilators which have been put down in the City of London for the Ventilation of the Sewers, I can give you a satisfactory account as far as our experience has yet gone.

As you are aware, in my Report on the Ventilation of Sewers, in September, 1858, I recommended that an experiment should be tried on a large scale with the charcoal, as a means of destroying the noxious gases which, in their passage from the sewers into the public way, were so constantly a source of annoyance and danger. Relying on the practical facts which you had already made public, as to the powerful disinfecting action of charcoal, I had no hesitation in recommending its use to the Commissioners of Sewers of this City. Acting on this advice, their Engineer, Mr. Haywood, put a large district of the City under treatment. He selected the worst district in his jurisdiction, namely, the Eastern Division of the Metropolis; a locality densely populated and inhabited by a very poor class of persons. The area of the experiment is about fifty acres; it has about seventeen hundred houses and 14,500 inhabitants. It is completely isolated, and every opening for ventilation has been

provided with a charcoal air-filter. In this way 103 filters have been put down; and although the sewage of the district is extremely bad, yet no unpleasant effects have been observed, either in the atmosphere of the sewers, or on the outside of the ventilators. No hindrance has been offered to ventilation, so that the men can enter the sewers as usual, and the air-filters have completely arrested the flow outwards of the foul gases, so that no offence or annoyance is now observed, except at the gully openings, which have not been provided with charcoal filters. The experiment has been progressing during the whole of the last summer; and although the season has not been as warm as usual, yet the results are sufficiently satisfactory to warrant us in expecting the most complete success.

I may further add, that one of the charcoal ventilators was put up about two years ago, in a locality where the escape of the sewer gases had been a source of great annoyance and injury to health; and notwithstanding that it has been in action for two years, yet it is still as perfect as ever; nothing having been done to it during the whole of that time. It has acted most efficiently in the destruction of the noxious gases.

I am of opinion, from all this, that the employment of your charcoal air-filters will be found of the greatest service in every large town where the sewers must be ventilated.

I remain,

Yours truly,

(Signed)

HENRY LETHEBY.

Letter from GEORGE A. H. CAPES, Esq., Surgeon, late of
22, Philpot-lane, City.

2, ADDISCOMBE VILLAS, CROYDON,

Dec. 12, 1860.

MY DEAR SIR,—

Although I have not the pleasure of personal acquaintance, your labours in the cause of sanitary improvements have made your name familiar.

Some years before I left the City, the state of the sewer in Philpot-lane demanded urgent treatment to abate the stench, of which everybody complained; various remedies were tried, with partial success; and in March and April, 1858, nine or ten deaths occurring almost together, I had several interviews with Dr. Letheby and Mr. Haywood, by direction of the Commissioners of Sewers; and it was agreed a ventilator, containing charcoal on trays, should be erected in Philpot-lane, communicating with the highest point of the sewer; and the present apparatus, resembling in external appearance a dead lantern, was fixed. The effect has been entirely to abate the nuisance, and remove all noxious smell from the locality.

Allow me to add,—for the last eleven years I have continually used peat charcoal in my water-closets in London, with the happiest effect.

I am,

My dear Sir,

Yours very faithfully,

GEORGE A. H. CAPES.

Dr. Stenhouse.

Letter from WILLIAM HAYWOOD, Esq., C.E., Engineer to the
City of London Commissioners of Sewers.

CITY SEWERS.

ENGINEER AND SURVEYOR'S OFFICE,
39, KING-STREET, CHEAPSIDE, E.C.,
Dec. 12, 1860.

DEAR SIR,—

I beg to state, in answer to your inquiry, that the experiment of the application of charcoal to prevent the emanations from the sewer ventilators, has now been in operation about five months.*

* I understand the charcoal was introduced into the filters about the end of June, but the charcoal filter particularly alluded to by Dr. Letheby, has been in operation for two years.—J. S.

The area where it is applied is one of the most densely inhabited in the City of London, and comprises about fifty-nine acres; the length of sewers is three miles and a quarter; the number of ventilators, 103.

The season has been so exceptional, that the indications from the experiment have not been so clear as I could wish; but from what has been observed, I consider the result, as far as it goes, to be satisfactory; and that the ventilation of the sewers has not been materially impeded by the application of the charcoal sieves;—if it were so, an additional number of ventilators would rectify that evil.

Truly yours,

WILLIAM HAYWOOD.

Dr. Stenhouse.

Letter from ROBERT RAWLINSON, Esq., C.E.

34, PARLIAMENT-STREET, WESTMINSTER, S.W.,

Nov. 23, 1860.

DEAR SIR,—

I am sorry I was not in when you did me the honour to call at my office. It will give me great pleasure to show you my plan of using charcoal for disinfecting sewage gases should you call again. I have applied this mode of sewer ventilation on a large scale at West Ham, near London; at Worksop, at Swansea, and at Buxton (the entire towns); at Brighton partially; at Bowood, the seat of Lord Lansdowne, and at other places. I shall never, in future, execute any sewers or drains without the intervention of charcoal-boxes to burn off the gases at the points of outlet. I gave the City Surveyor, Mr. Haywood, copies of my plans, but do not know if he has used them, or intends to do so. The entire Metropolis may, in my opinion, be freed from sewer gas smell, if charcoal is used as you originally proposed, and as I have applied it. The plan is simple and inexpensive; the material is abundant and cheap. I have not pub-

lished my plans, or in any way attempted to direct public attention to the plan, but determined to avoid discussion and abuse, by executing the work and leaving results to time. I shun patents, and dread being thought an inventor, as I find ten people ready to abuse for one to encourage; and the old cry, "Nothing new in that," &c. &c. &c.

I am,

Your obedient Servant,

(Signed)

ROBERT RAWLINSON.

To Dr. Stenhouse, London.

Extract from Mr. RAWLINSON'S Report on the Completion of
Worksop Main Sewerage Works, 4th Dec., 1860.

"The entire system of sewers in Worksop is fully ventilated by special arrangements for this purpose, at fifty-one places, and these include all upper ends of sewers.

"There are side-chambers having screens of charcoal intervening, through which any sewer gases must unceasingly flow; and Dr. Stenhouse has proved that such gases are oxidized by contact with the charcoal, so as to render them innoxious.

"The process is silently carried on continuously, and at very little cost. A few shillings per annum to renew any charcoal which has become wet, and to cleanse out the ventilating shafts from road dirt, which may have worked through the surface grates by the road traffic above, is all that will be required.

"This charcoal-ventilating arrangement is a new feature in town sewerage, and Worksop is one of the first towns in which the system has been put into operation."

ADDITIONAL OBSERVATIONS BY R. RAWLINSON, Esq., C.E.

“Provision was made in the places named below, at about the dates given.

| | | |
|--|-----------------------|----------------------|
| West Ham, | June, 1858, | about 250 in number. |
| Brighton, | April, 1859, | 4 |
| Workshop, | December, 1858, | 51 |
| Swansea, | December, 1859, about | 70 |
| Buxton, | January, 1860, „ | 35 |
| Bowood, the seat of } Lord Lansdowne, } | January, 1860, | 6 |

Total number, 416

“Plans were made some time in 1856, by myself, on my return from the Crimea, as I had seen the useful effects of charcoal in the hospitals on the Bosphorus, and in the Crimea, Dr. Stenhouse having gratuitously sent out by the members of the Sanitary Commission, early in the spring of 1855, several of his admirable charcoal respirators.

“Mr. Crozier, Engineer at Sunderland, also used charcoal to disinfect sewer gases in the year 1856.

“Up to this time I have put in use upwards of four hundred charcoal ventilators in sewers executed, and shall continue to use them in future. No sewer should be allowed to be without adequate means for ventilation, and most certainly no ventilator should be without the arrangement of charcoal proposed by Dr. Stenhouse.”

By the same Author. Third Edition, price 6d.

A LECTURE

ON THE ECONOMICAL APPLICATION OF CHARCOAL TO SANITARY PURPOSES,

Delivered at the Royal Institution, March 2, 1855.

London: JOHN CHURCHILL, New Burlington Street.

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